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MEMORANDUM REPORT M65-21-1

# HUMAN FACTORS COMPARISON OF THREE TYPES OF SMALL ARMS SIGHTS

by

SP4 Daniel A. Triolo
Thomas G. Jadico

AMCMS 5522.11.080

DA Project 1C522301A080



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UNITED STATES ARMY
FRANKFORD ARSENAL
PHILADELPHIA, PA.

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QUALITY ASSURANCE DIRECTORATE

FRANKFORD ARSENAL

PHILADELPHIA, PA. 19137

## ABSTRACT

This report includes a description of the sights and weapons used, the type of lighting and target conditions, range, and the method used for testing. The problems of sight alignment with the short base reflecting tube sight are discussed. Tables of results are included in Appendix A.

A short base reflecting tube sight containing cross hairs, and a short base open notch and blade sight were constructed and mounted on rifles. They were fired for score for a general comparison as against that of a conventional long base peep sight, and to determine which of the short base sights were more effective.

Ten subjects fired the short base reflecting tube sight, the short base open notch and blade sight, and a conventional long base peep sight alternately for score under different lighting and target conditions. The extreme spread of the shot groups obtained with each sight and the sight and fire time for each round fired were measured and the data recorded.

The conventional long base peep sight showed the best results. The subjects found it difficult to obtain sight alignment with the short base reflecting tube sight. The shot groups and firing times with the short base open notch and blade sight were significantly better than those obtained with the short base reflecting tube sight.

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# INTRODUCTION

The problems of an open sight are well known. It is impossible when using the post or blade front sight to focus on both the blade and the target. The amount of time it takes and the eye fatigue that results in trying to focus back and forth between the front blade and the target has been a problem shooters have had to live with. The shooter usually compromises by focusing on the post itself and holds the post in relation to an out of focus target. For anyone other than an experienced "crack" shot this becomes difficult if the shooter is trying to hit a target with speed and accuracy.

The specifications for the development of a sight are controlled by the type of weapon on which it will be mounted, the size and shape of the weapon, the portability of the weapon, the personnel using the weapon, and the job the weapon is to accomplish. It should be constructed to give the shooter the quickest and most accurate means to sight and fire on a target. The conventional long base peep sight has been developed through the years and has proved to be the best small arms weapon sight to date.

Short base sights create a problem in that the reduction in length between the front and rear sights automatically reduce the alignment accuracy between weapon and target. A short base sight that could compare in accuracy and sight and fire time with a long base sight would be ideal and could lead to further sight improvement on all small arms weapons. The short base reflecting tube sight was constructed to give the shooter another aid in increasing accuracy.

The purpose of this study was to determine whether the short base reflecting tube sight showed a significant improvement over the short base open notch and blade sight and whether it could compare favorably with the conventional long base peep sight.

## DESCRIPTION

### Reflecting Tube Sight and Weapons Specifications

The tube sight used in the testing was made of polished steel, 7" long with an outside diameter of 3/4" and an inside diameter of 3/8". Cross hairs made of black waxed cord .008" in diameter were placed inside, and 1/8" from the end of the tube. The inside of the tube was polished. The sight was mounted on a Remington target rifle, model 40 X, by using a set of Lyman target mounts. It was mounted directly in front of the breech of the rifle with the center of the tube 3/4" from the top of the breech (see figures 1 and 2). When the subject was in a firing position and maintained a spot or cheek weld, the front of the tube sight was approximately 10" from his eye. Slight variations occurred from subject to subject.

A Remington target rifle, model 40 X, mounted with Redfield olympic sights of the post type was used for comparative evaluation (see figure 3). These sights were used because of their overall similarity with most army sights mounted on small caliber weapons. Twenty-two match ammunition was used in both weapons.

### Range

An indoor range was used throughout the testing. All the firing was done using official 50 ft. slow fire pistol targets at a range of 30 meters. The subjects fired from a prone sandbag rest position.

### Lighting

Photoflood lights were used to maintain lighting conditions. A photoflood light was set 3 ft. in front of and 3 ft. to the side of the target on each side of and facing the target. Two photoflood lights were set 3 ft. in front of and 2 ft. below and facing toward the target. Three photoflood lights were set on the center of the range floor at 10-meter intervals facing toward the target. Permanent overhead lighting installed in the range was used except when firing was done under low level lighting conditions which were controlled with variacs. The photoflood lights used were 600 watts. For maximum light conditions all the lights were

Figure 1. Reflecting Tube Sight Mounted on a Remington Target Rifle

Figure 2. Reflecting Tube Sight

Figure 3. Redfield Olympic Sight of the Post Type Mounted on a Remington Target Rifle

controlled by variac settings of 100. This setting gave the following readings on a 2-1/3 degree Pentax light meter:

At the firer's position, 30 meters from the target, the open target gave a scale reading of 17 on the Pentax meter.

The open target gave a reading of 18 at 3 meters from the target.

The reading off the left wall midway from the firer's position was 11. The same reading was recorded off the right wall.

The reading off the floor midway from the firer's position was 13.

The reading off the ceiling midway from the firer's position was 11.

At the firer's position, 30 meters from the target, the masked target gave a reading of 15.5.

At 15 meters the masked target gave a reading of 16.

At 3 meters the masked target gave a reading of 17.5.

During the B series the variacs were set at 60. This was called "medium" light conditions.

During the C series the variacs were set at 20. The overhead lighting was turned off during the C series. This was called "low" light conditions.

The lighting was extremely dim during the C series. The bull on the target was barely discernible. Each subject was given 20 minutes prior to firing the C series to allow his eyes to become dark adapted.

## Subjects

The ten subjects who were engaged in this study were U. S. Army enlisted personnel. Six of the subjects held college degrees and were serving in science and engineering programs; four of the subjects held high school diplomas and were serving as drivers. All of the subjects

had qualified with either M1 rifles, M14 rifles, or carbines. Each subject was given a thorough eye examination prior to testing and no eye correction measures were found necessary.

## PROCEDURES

The method of sight alignment with the reflecting tube sight involves sighting down the inside of the tube, placing the cross hairs on the center of the bull and then aligning in parallel the four line reflections that the cross hairs cast down the center of the tube.

After an introduction to the mechanics of the tube sight and verbal instructions so as to achieve the proper sight alignment, which included showing illustration of proper and improper sight alignment, each subject fired a number of familiarization rounds with both weapons. When firing familiarization rounds using the tube sight, each subject continued firing until he reached a skill level that did not vary significantly from shot group to shot group. Not until this point was reached by each subject was the final firing test conducted. Thirty rounds were fired for familiarization by each subject with the olympic sights. No further familiarization rounds were required with this sight since all the subjects had qualified for record with long base open blade peep sight weapons just prior to testing.

After each subject had fired familiarization rounds with both weapons the following testing was conducted:

Each subject fired 10 rounds at an open target using the Redfield olympic sights under maximum lighting conditions - A1a.

The target was replaced and the subject then fired 10 rounds using the tube sight under the same lighting conditions - A1b. The amount of time it took the subject to sight and fire each round was recorded. (The sight and fire time was measured with a stop watch. As soon as the subject obtained a firm and steady spot or cheek weld the watch was started. The watch was stopped when the round was fired, and the time was recorded.) This constituted the first target condition using both sights in the A series (A1a, A1b).

The subject then fired under the second target condition – the masked target. The same procedure was followed under the same lighting conditions (A2a, A2b). The masked targets consisted of the pistol targets with the bull surrounded by a solid black border cut in a large jagged manner. Three points of the mask touched the outside perimeter of the bull. At no point was the bull covered by the mask (see figure 4).

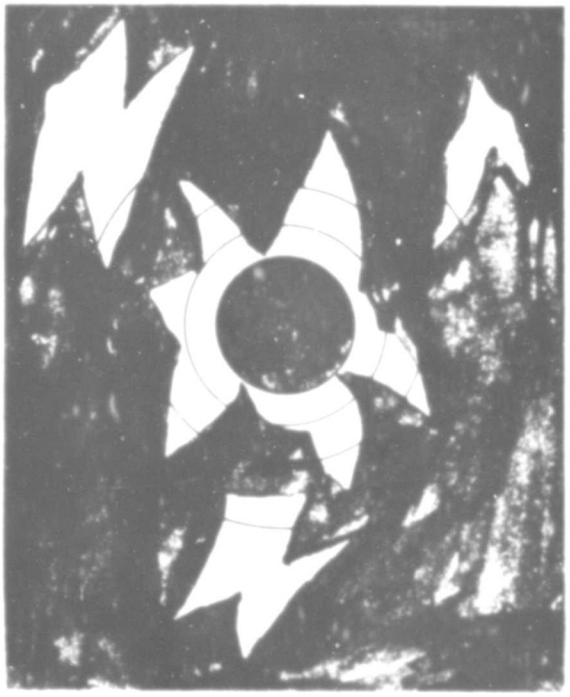

Figure 4. Masked 50 ft. Slow Fire Pistol Target

The subject then fired under the third target condition – a bush placed immediately in front of the subject and weapon. The same procedure was followed (A3a, A3b). The three target conditions constituted a series labeled the A series.

These three target conditions, firing procedures, and recording procedures were repeated in a B series (B1a, B1b, B2a, B2b, B3a, B3b); and a C series (C1a, C1b, C2a, C2b, C3a, C3b). The B series varied only in the lighting condition. The B series lighting conditions was

lowered to what was called "medium light". The C series varied from the A series only in the lighting condition. The C series lighting condition was lowered to what was called "low light".

Each subject fired 60 rounds in each series, 30 rounds being fired using the long base olympic sight and 30 rounds being fired using the tube sight. An overall total of 180 rounds were fired for record by each subject in the three series. The test procedure was counter balanced with respect to the sights.

## Data Procedure

Because of the nature of the test there was no concern with target bull scores per se. The main interest was in the size of the shot groups. Blank targets without bulls could have been used except for the fact that it was found more advantageous in instructing the subjects in the use of the tube sight to be able to call shots in relation to their placement on a bull target. In recording the shot group data, it was established that the best method for determining the size of the shot groups was to measure the distance between the two farthest shots on a target (extreme spread). An allowance was made for two thrown shots per 10 round shot group. If one or two shots were well outside a general shot group they were disallowed and not used in determining the size of the group.

The data was recorded for the time to sight and fire by averaging the time to sight and fire each round in a 10 shot group.

## Problems of Sight Alignment With Reflecting Tube Sight

Each subject underwent a period of instruction with the tube sight which included the firing of familiarization rounds. It took an average of four hours of intensified training and instructions with each subject before he could use the tube sight with any type of proficiency. It was difficult to clarify the basic method of sight alignment with the tube sight to 80 percent of the subjects. The proper use of the sight created a number of inherent instruction problems which proved somewhat difficult to overcome.

The difficulty in sight alignment was fourfold:

First, the subject could not get a clear picture of the bull and the cross hairs at the same time. Each subject reported that he got a double and sometimes a triple vision effect with the cross hairs when trying to center and focus on the bull. When trying to focus on the cross hairs, the subjects reported that the bull appeared as one, and sometimes two fuzzy blurs.

Second, to align the line reflections of the cross hairs in parallel down the inside of the tube was a major problem in itself for the subjects. The subjects, maintaining a good spot or cheek weld, still found it difficult to hold the line reflections in parallel. The slightest movement of the eye, head, or weapon caused the reflections to cant out of parallel.

Third, the greatest problem arose when the subjects tried to flick their focus back and forth between (1) the cross hairs and bull and (2) the cross hair line reflections. Once they had assumed placement of the cross hairs on the bull and then focused and assumed a proper line reflection alignment, they found that the cross hair and bull would once again be improperly aligned.

Fourth, the constant flickering of focus back and forth created severe eye fatigue in all the subjects. Pain and watering of the eyes were not unusual; therefore, it was necessary when using the tube sight to allow the subjects periodic rest to alleviate their eye strain.

A minor problem arose each time a subject was introduced to the mechanics of the tube sight in persuading him that a sight alignment was possible.

## OPEN NOTCH AND BLADE SIGHT DESCRIPTION AND PROCEDURES

The open notch and blade sight was made of blackened steel with a base line of 6 inches. The blade was of the Redfield post type and the top of the blade was 1/2 in. from the top of the barrel. The open notch

was the Williams type and the top of the notch assembly was 3/16" from the breech of the weapon. The front of the sight was mounted directly in front of the breech and was approximately 10" from the eye of the subject when he was in firing position. The notch itself was square cut, 3/32" wide and 1/16" deep. The blade was 1/16" wide (see figures 5 and 6).

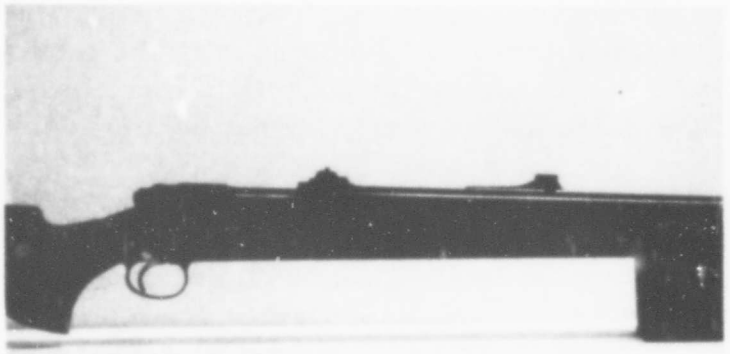

Figure 5. Short Base Notch and Blade Sight Mounted on a Remington Target Rifle

Figure 6. Short Base Notch and Blade Sight

The six subjects selected for this testing were taken from the group of ten that were engaged in testing the tube sight.

Since data had already been obtained on the Redfield olympic sight the testing involved only the open notch and blade sight. This sight was mounted on the same weapon that had been used with the tube sight. The stock of the weapon was modified so that the position from the subject's eye to the sight was the same as the distance that occurred when testing the tube sight.

The same range, prone sandbag rest position, method of scoring and timing, masking of targets, and method of lighting were used in this test as in the comparative test of the tube sight. The maximum lighting conditions used in the testing of the tube sight were repeated and held constant throughout this entire test.

Each subject fired 40 familiarization rounds with the open notch and blade sight. It was found that 40 rounds were more than sufficient in obtaining a skill level for each subject.

The subject then fired for record. Ten rounds were fired at an open target and ten rounds were fired at a masked target by each subject.

The subjects aligned the open notch and blade sight by placing the top of the blade on the bottom of the bull and then placing the blade in the center of the notch with the top of the blade in line with the top of the notch.

The subjects did not report any problems of unusual eye fatigue using the open notch and blade sight. This factor may have increased the sight and fire data times because of the subject's willingness to spend more time aligning the sight before firing a round.

## CONCLUSIONS

Although the problem of sight alignment with the reflecting tube sight shows up primarily in the comparative sight and fire time data, it

was found that the subjects very often became so impatient with the constant problem of sight alignment that they would fire a round even though they realized that the alignment was not what it could or should be. This makes the sight and fire time data for the tube sight somewhat erroneous, which led to the conjecture that if each of the subjects had been more patient, the sight and fire time data averages would have been greatly increased.

The test results clearly show that the reflecting tube sight tested does not increase either accuracy or sight and fire time over the open notch and blade sight or the conventional long base peep sight.

Although the reflecting tube sight as it was tested did not show an improvement over the other two sights, the conception of the sight does provide another aid in obtaining an accurate sight alignment. Verbal reports from the subjects indicated that had it not been for the difficulty in eye fatigue, they felt the sight would have proven effective.

## RECOMMENDATIONS

Further testing should be conducted with both of the short base sights. Different methods of instruction could reduce the learning time in the use of the reflecting tube sight. Refinements and improvements in the construction of the sight such as the degree of reflection within the tube and the type of cross hairs used could greatly improve its use and effectiveness.

A number of variations of the open notch and blade sight such as the height and width of the blade and the cut of the notch should also be considered and tested. These factors are basically related to the accuracy of the sight.

## APPENDIX A - FIRING RESULTS

### Table I. REFLECTING TUBE SIGHT

| Subjects | A1b | | A2b | | A3b | | B1b | | B2b | | B3b | | C1b | | C2b | | C3b | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | T | SG | T | SG | T | SG | T | SG | T | SG | T | SG | T | SG | T | SG | T | SG |
| 1 | 13.7 | 1.80 | 15.4 | 3.00 | 15.4 | 1.95 | 16.4 | 2.60 | 23.4 | 3.10 | 27.2 | 3.45 | 18.9 | 2.20 | 23.2 | 5.15 | 25.3 | 3.40 |
| 2 | 14.1 | 3.53 | 20.4 | 5.10 | 14.7 | 4.15 | 20.1 | 3.55 | 13.5 | 4.80 | 13.1 | 5.00 | 17.2 | 5.00 | 18.9 | 11.50 | 15.0 | 4.60 |
| 3 | 29.7 | 8.25 | 30.3 | 4.38 | 31.5 | 5.63 | 35.3 | 3.13 | 41.1 | 5.00 | 33.5 | 5.88 | 39.7 | 5.19 | 37.9 | 4.44 | 32.0 | 6.06 |
| 4 | 32.7 | 6.19 | 29.9 | 7.31 | 30.5 | 4.94 | 29.3 | 4.84 | 25.6 | 4.94 | 25.6 | 7.06 | 31.4 | 8.81 | 20.5 | 7.75 | 18.3 | 8.75 |
| 5 | 33.2 | 6.44 | 27.4 | 14.19 | 24.6 | 12.38 | 17.5 | 7.69 | 16.1 | 7.69 | 29.7 | 3.38 | 19.3 | 9.38 | 23.8 | 7.31 | 20.8 | 7.63 |
| 6 | 32.7 | 2.06 | 28.7 | 3.44 | 26.9 | 2.13 | 32.0 | 3.44 | 33.0 | 4.88 | 26.0 | 3.50 | 18.3 | 2.69 | 26.2 | 5.31 | 23.9 | 2.75 |
| 7 | 33.2 | 3.75 | 32.1 | 4.50 | 40.1 | 3.13 | 32.8 | 4.50 | 39.0 | 5.56 | 32.5 | 2.81 | 35.7 | 4.75 | 33.8 | 6.56 | 25.0 | 5.69 |
| 8 | 14.7 | 5.95 | 23.4 | 6.63 | 20.8 | 7.00 | 15.0 | 4.56 | 15.1 | 8.19 | 14.5 | 6.31 | 11.1 | 10.31 | 20.5 | 9.56 | 13.2 | 13.19 |
| 9 | 26.6 | 7.63 | 19.8 | 7.69 | 15.0 | 4.63 | 10.3 | 5.31 | 8.6 | 5.75 | 9.5 | 6.63 | 11.8 | 8.19 | 9.8 | 10.19 | 12.0 | 8.06 |
| 10 | 28.7 | 3.06 | 25.8 | 3.65 | 23.1 | 3.69 | 24.3 | 4.13 | 37.1 | 6.31 | 29.6 | 2.19 | 27.9 | 4.00 | 27.0 | 5.31 | 22.2 | 6.63 |
| Mean Totals | 25.9 | 4.87 | 25.3 | 5.99 | 23.3 | 4.96 | 23.3 | 4.39 | 25.3 | 5.61 | 24.1 | 4.60 | 23.1 | 6.05 | 24.2 | 7.31 | 20.8 | 6.38 |

**Key:**

A. - Max. Light
B - Med. Light
C - Min. Light
1 - Open Target
2 - Masked Target
3 - Man Behind Bush
a - Standard Base Line
Redfield Clympic Sight

b - Tube Sight
c - Open Blade and Notch Sight

T = Sight and Time Average in Seconds (Average time of a ten round shot group)

SG = Shot Group Diameter in Inches (Extreme Spread)

Table II. SHORT BASE OPEN NOTCH AND BLADE SIGHT

| Subjects | A1C | | A2C | |
|---|---|---|---|---|
| | T | SG | T | SG |
| 1 | 12.1 | 2.58 | 21.0 | 3.06 |
| 2 | 10.0 | 2.5 | 10.8 | 4.25 |
| 3 | 24.7 | 2.94 | 25.7 | 2.69 |
| 4 | 16.1 | 4.31 | 21.0 | 4.75 |
| 5 | 33.5 | 2.06 | 17.8 | 2.75 |
| 6 | 25.8 | 3.5 | 26.4 | 3.93 |
| Mean Totals | 20.3 | 2.98 | 20.4 | 3.57 |

Key:

A - Max. Light
B - Med. Light
C - Min. Light
1 - Open Target
2 - Masked Target
3 - Man Behind Bush
a - Standard Base Line
Redfield Olympic Sight
b - Tube Sight
c - Open Blade and Notch Sight

T = Sight and Time Average in Secords (Average time of a ten round shot group)
SG = Shot Group Diameter in Inches (Extreme Spread)

Table III. OLYMPIC SIGHT

| Subjects | A1a | | A2a | | A3a | | B1a | | B2a | | B3a | | C1a | | C2a | | C3a | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | T | SG | T | SG | T | SG | T | SG | T | SG | T | SG | T | SG | T | SG | T | SG |
| 1 | 14.7 | .65 | 12.7 | .80 | 17.5 | .50 | 17.8 | .50 | 16.1 | .60 | 28.9 | .40 | 16.0 | 1.05 | 13.3 | 1.40 | 12.1 | 1.10 |
| 2 | 8.7 | .65 | 5.6 | .88 | 4.9 | 1.00 | 8.9 | 1.25 | 10.0 | 1.05 | 11.1 | 1.30 | 12.1 | .80 | 10.3 | 1.15 | 8.7 | 1.30 |
| 3 | 10.9 | 1.88 | 20.7 | 1.38 | 16.7 | 1.00 | 24.8 | 1.44 | 27.0 | 1.94 | 21.0 | 1.25 | 21.8 | 2.13 | 33.6 | 1.99 | 23.0 | 2.25 |
| 4 | 15.0 | 1.00 | 18.0 | 1.25 | 14.5 | .90 | 19.2 | 2.81 | 17.8 | 2.44 | 12.7 | 1.88 | 12.4 | 1.56 | 15.2 | 2.89 | 14.2 | 2.19 |
| 5 | 17.6 | 1.63 | 20.2 | 2.00 | 18.0 | 1.44 | 6.5 | 1.38 | 9.8 | 2.69 | 13.9 | 1.31 | 15.6 | 2.38 | 13.6 | 2.56 | 13.3 | 2.13 |
| 6 | 9.3 | .88 | 13.4 | 1.38 | 9.5 | 1.19 | 12.1 | .75 | 11.7 | 1.81 | 8.0 | 1.19 | 6.0 | 1.63 | 14.0 | 1.50 | 6.4 | 1.50 |
| 7 | 14.3 | .69 | 13.2 | 1.19 | 13.5 | 1.38 | 9.3 | 1.13 | 14.5 | 1.13 | 14.1 | .75 | 16.2 | 1.19 | 15.7 | 1.75 | 11.3 | 1.56 |
| 8 | 15.2 | 1.65 | 8.9 | 1.50 | 7.6 | 1.88 | 5.2 | .99 | 5.6 | 1.13 | 6.9 | 1.00 | 7.1 | 1.50 | 7.4 | 2.25 | 6.4 | 5.00 |
| 9 | 10.0 | 1.13 | 14.8 | 1.75 | 9.0 | 1.44 | 5.3 | 2.19 | 4.1 | 1.50 | 6.5 | 1.38 | 8.0 | .88 | 8.0 | 1.38 | 6.0 | 2.56 |
| 10 | 13.5 | .81 | 16.3 | 1.00 | 13.5 | 1.44 | 20.5 | .44 | 18.5 | .50 | 18.0 | .81 | 14.9 | .81 | 15.0 | .94 | 14.9 | .75 |
| Totals | 12.9 | 1.10 | 14.4 | 1.31 | 12.5 | 1.22 | 13.0 | 1.29 | 13.5 | 1.48 | 14.1 | 1.13 | 13.0 | 1.40 | 14.6 | 1.78 | 11.6 | 2.03 |

Max. Light
Med. Light
Min. Light
Open Target
Masked Target
Man Behind Bush
Standard Base Line
Redfield Olympic Sight

b = Tube Sight
c = Open Blade and Notch Sight

T = Sight and Time Average in Seconds (Average time of a ten round shot group)

SG = Shot Group Diameter in Inches (Extreme Spread)

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